What is claimed is:

1. A control apparatus comprising:

reference input-calculating means for calculating a reference input;

limiting value-calculating means for calculating a limiting value for limiting the reference input;

modulation output-calculating means for inputting the calculated limiting value to one of a $\Delta\Sigma$ modulation algorithm and a $\Sigma\Delta$ modulation algorithm, thereby calculating a modulation output as an output from the one of the modulation algorithms; and

control input-calculating means for calculating a control input to the controlled object according to the calculated modulation output,

wherein said limiting value-calculating means sets the limiting value to a value which is identical in sign to the reference input and equal in absolute value to the modulation output when the absolute value of the reference input is larger than the absolute value of the modulation output, and to a value which is equal to the reference input when the absolute value of the reference input is equal to or smaller than the absolute value of the modulation output.

2. A control apparatus as claimed in claim 1, further comprising detection means for detecting an output from the controlled object, and

wherein said reference input-calculating means calculates the reference input based on an output deviation which is a deviation between the detected output from the controlled object and a predetermined target value, and

wherein said control input-calculating means sets

the control input, according to the modulation output, to such a value that the detected output from the controlled object converges to the target value.

3. A control apparatus as claimed in claim 2, wherein said reference input-calculating means sets the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

4. A control apparatus comprising:

reference input-calculating means for calculating a reference input;

modulation output-calculating means for inputting the calculated reference input to a $\Delta\Sigma$ modulation algorithm, thereby calculating a modulation output as an output from the $\Delta\Sigma$ modulation algorithm; and

control input-calculating means for calculating a control input to the controlled object according to the calculated modulation output,

wherein said modulation output-calculating means includes limiting means for limiting an integral of an input deviation which is a deviation between the reference input and the modulation output, in the $\Delta\Sigma$ modulation algorithm, to a value within a predetermined limited range.

5. A control apparatus as claimed in claim 4, further comprising detection means for detecting an output from the controlled object, and

wherein said reference input-calculating means calculates the reference input based on an output deviation which is a deviation between the detected output from the controlled object and a predetermined target value, and

wherein said control input-calculating means sets the control input, according to the modulation output, to such a value that the detected output from the controlled object converges to the target value.

6. A control apparatus as claimed in claim 5, wherein said reference input-calculating means sets the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

7. A control apparatus for an internal combustion engine including an exhaust passage through which exhaust gases flow, comprising:

an air-fuel ratio sensor for outputting a detection signal indicative of an air-fuel ratio of the exhaust gases flowing through the exhaust passage;

reference input-calculating means for calculating a reference input based on an output deviation which is a deviation between the output from said air-fuel ratio sensor and a predetermined target value;

limiting value-calculating means for calculating a limiting value for limiting the reference input;

modulation output-calculating means for inputting the calculated limiting value to one of a $\Delta\Sigma$ modulation algorithm and a $\Sigma\Delta$ modulation algorithm, thereby calculating a modulation output as an output from the one of the modulation algorithms; and

air-fuel ratio control means for controlling an air-fuel ratio of a mixture supplied to the engine, according to the calculated modulation output, such that the output from said air-fuel ratio sensor converges to the target value,

wherein said limiting value-calculating means

sets the limiting value to a value which is identical in sign to the reference input and equal in absolute value to the modulation output when the absolute value of the reference input is larger than the absolute value of the modulation output, and to a value which is equal to the reference input when the absolute value of the reference input is equal to or smaller than the absolute value of the modulation output.

8. A control apparatus as claimed in claim 7, wherein the exhaust passage has a catalytic device disposed therein, and

wherein said reference input-calculating means sets the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

9. A control apparatus for an internal combustion engine including an exhaust passage through which exhaust gases flow, comprising:

an air-fuel ratio sensor for outputting a detection signal indicative of an air-fuel ratio of the exhaust gases flowing through the exhaust passage;

reference input-calculating means for calculating a reference input based on an output deviation which is a deviation between the output from said air-fuel ratio sensor and a predetermined target value;

modulation output-calculating means for inputting the calculated reference input to a $\Delta\Sigma$ modulation algorithm, thereby calculating a modulation output as an output from the $\Delta\Sigma$ modulation algorithm; and

air-fuel ratio control means for controlling an air-fuel ratio of a mixture supplied to the engine according to the calculated modulation output such that

the output from said air-fuel ratio sensor converges to the target value,

wherein said modulation output-calculating means includes limiting means for limiting an integral of the input deviation between the reference input and the modulation output, in the $\Delta\Sigma$ modulation algorithm, to a value within a predetermined limited range.

10. An control apparatus as claimed in claim 9, wherein the exhaust passage has a catalytic device disposed therein, and

wherein said reference input-calculating means sets the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

11. A control method of controlling a controlled object, comprising:

a reference input-calculating step of calculating a reference input;

a limiting value-calculating step of calculating a limiting value for limiting the reference input;

a modulation output-calculating step of inputting the calculated limiting value to one of a $\Delta\Sigma$ modulation algorithm and a $\Sigma\Delta$ modulation algorithm, thereby calculating a modulation output as an output from the one of the modulation algorithms; and

a control input-calculating step of calculating a control input to the controlled object according to the calculated modulation output,

wherein said limiting value-calculating step includes setting the limiting value to a value which is identical in sign to the reference input and equal in absolute value to the modulation output when the

absolute value of the reference input is larger than the absolute value of the modulation output, and to a value which is equal to the reference input when the absolute value of the reference input is equal to or smaller than the absolute value of the modulation output.

12. A control method as claimed in claim 11, further comprising a detection step of detecting an output from the controlled object, and

wherein said reference input-calculating step includes calculating the reference input based on an output deviation which is a deviation between the detected output from the controlled object and a predetermined target value, and

wherein said control input-calculating step includes setting the control input, according to the modulation output, to such a value that the detected output from the controlled object converges to the target value.

13. A control method as claimed in claim 12, wherein said reference input-calculating step includes setting the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

14. A control method of controlling a controlled object, comprising:

a reference input-calculating step of calculating a reference input;

a modulation output-calculating step of inputting the calculated reference input to a $\Delta\Sigma$ modulation algorithm, thereby calculating a modulation output as an output from the $\Delta\Sigma$ modulation algorithm; and

a control input-calculating step of calculating a control input to the controlled object according to the calculated modulation output,

wherein said modulation output-calculating step includes a limiting step of limiting an integral of an input deviation which is a deviation between the reference input and the modulation output, in the $\Delta\Sigma$ modulation algorithm, to a value within a predetermined limited range.

15. A control method as claimed in claim 14, further comprising a detection step of detecting an output from the controlled object, and

wherein said reference input-calculating step includes calculating the reference input based on an output deviation which is a deviation between the detected output from the controlled object and a predetermined target value, and

wherein said control input-calculating step includes setting the control input, according to the modulation output, to such a value that the detected output from the controlled object converges to the target value.

16. A control method as claimed in claim 15, wherein said reference input-calculating step includes setting the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

17. A control method of controlling an internal combustion engine including an exhaust passage through which exhaust gases flow,

the method comprising:

an air-fuel ratio-detecting step of detecting an

air-fuel ratio of the exhaust gases flowing through the exhaust passage;

a reference input-calculating step of calculating a reference input based on an output deviation which is a deviation between the detected air-fuel ratio and a predetermined target value;

a limiting value-calculating step of calculating a limiting value for limiting the reference input;

a modulation output-calculating step of inputting the calculated limiting value to one of a $\Delta\Sigma$ modulation algorithm and a $\Sigma\Delta$ modulation algorithm, thereby calculating a modulation output as an output from the one of the modulation algorithms; and

an air-fuel ratio control step of controlling an air-fuel ratio of a mixture supplied to the engine such that the detected air-fuel ratio converges to the target value,

wherein said limiting value-calculating step include setting the limiting value to a value which is identical in sign to the reference input and equal in absolute value to the modulation output when the absolute value of the reference input is larger than the absolute value of the modulation output, and to a value which is equal to the reference input when the absolute value of the reference input is equal to or smaller than the absolute value of the modulation output.

18. A control method as claimed in claim 17, wherein the exhaust passage has a catalytic device disposed therein, and

wherein said reference input-calculating step includes setting the reference input to a value obtained by multiplying the output deviation by a

predetermined different value dependent on whether the output deviation is a positive value or a negative value.

19. A control method of controlling an internal combustion engine including an exhaust passage through which exhaust gases flow,

the method comprising:

an air-fuel ratio-detecting step of detecting an air-fuel ratio of the exhaust gases flowing through the exhaust passage;

a reference input-calculating step of calculating a reference input based on an output deviation which is a deviation between the detected air-fuel ratio and a predetermined target value;

a modulation output-calculating step of inputting the calculated reference input to a $\Delta\Sigma$ modulation algorithm, thereby calculating a modulation output as an output from the $\Delta\Sigma$ modulation algorithm; and

an air-fuel ratio control step of controlling an air-fuel ratio of a mixture supplied to the engine according to the calculated modulation output such that the detected air-fuel ratio converges to the target value,

wherein said modulation output-calculating step includes a limiting step of limiting an integral of an input deviation between the reference input and the modulation output, in the $\Delta\Sigma$ modulation algorithm, to a value within a predetermined limited range.

20. An control method as claimed in claim 19, wherein the exhaust passage has a catalytic device disposed therein, and

wherein said reference input-calculating step includes setting the reference input to a value

obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

21. A control unit including a control program for causing a computer to control a controlled object,

wherein the control program causes the computer to calculate a reference input, calculate a limiting value for limiting the reference input, input the calculated limiting value to one of a $\Delta\Sigma$modulation algorithm and a $\Sigma\Delta$ modulation algorithm, to thereby calculate a modulation output as an output from the one of the modulation algorithms, and calculate a control input to the controlled object according to the calculated modulation output, and

wherein when the control program causes the computer to calculate the limiting value, the control program causes the computer to set the limiting value to a value which is identical in sign to the reference input and equal in absolute value to the modulation output when the absolute value of the reference input is larger than the absolute value of the modulation output, and to a value which is equal to the reference input when the absolute value of the reference input is equal to or smaller than the absolute value of the modulation output.

22. A control unit as claimed in claim 21, wherein the control program further causes the computer to detect an output from the controlled object, and

wherein when the control program causes the computer to calculate the reference input, the control program causes the computer to calculate the reference input based on an output deviation which is a deviation

between the detected output from the controlled object and a predetermined target value, and

wherein when the control program causes the computer to calculate the control input, the control program causes the computer to set the control input, according to the modulation output, to such a value that the detected output from the controlled object converges to the target value.

23. A control unit as claimed in claim 22, wherein when the control program causes the computer to calculate the reference input, the control program causes the computer to set the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

24. A control unit including a control program for causing a computer to control a controlled object,

wherein the control program causes the computer to calculate a reference input, input the calculated reference input to a $\Delta\Sigma$ modulation algorithm, to thereby calculate a modulation output as an output from the $\Delta\Sigma$ modulation algorithm, and calculate a control input to the controlled object according to the calculated modulation output, and

wherein when the control program causes the computer to calculate the modulation output, the control program causes the computer to limit an integral of an input deviation which is a deviation between the reference input and the modulation output, in the $\Delta\Sigma$ modulation algorithm, to a value within a predetermined limited range.

25. A control unit as claimed in claim 24,

wherein the control program further causes the computer to detect an output from the controlled object, and

wherein when the control program causes the computer to calculate the reference input, the control program causes the computer to calculate the reference input based on an output deviation which is a deviation between the detected output from the controlled object and a predetermined target value, and

wherein when the control program causes the computer to calculate the control input, the control program causes the computer to set the control input, according to the modulation output, to such a value that the detected output from the controlled object converges to the target value.

26. A control unit as claimed in claim 25, wherein when the control program causes the computer to calculate the reference input, the control program causes the computer to set the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

27. An engine control unit including a control program for causing the computer to control an internal combustion engine including an exhaust passage through which exhaust gases flow,

wherein the control program causes the computer to detect an air-fuel ratio of the exhaust gases flowing through the exhaust passage, calculate a reference input based on an output deviation which is a deviation between the detected air-fuel ratio and a predetermined target value, calculate a limiting value for limiting the reference input, input the calculated

limiting value to one of a $\Delta\Sigma$ modulation algorithm and a $\Sigma\Delta$ modulation algorithm, to thereby calculate a modulation output as an output from the one of the modulation algorithms, and control an air-fuel ratio of a mixture supplied to the engine such that the detected air-fuel ratio converges to the target value, and

wherein when the control program causes the computer to calculate the limiting value, the control program causes the computer to set the limiting value to a value which is identical in sign to the reference input and equal in absolute value to the modulation output when the absolute value of the reference input is larger than the absolute value of the modulation output, and to a value which is equal to the reference input when the absolute value of the reference input is equal to or smaller than the absolute value of the modulation output.

28. An engine control unit as claimed in claim 27, wherein the exhaust passage has a catalytic device disposed therein, and

wherein when the control program causes the computer to calculate the reference input, the control program causes the computer to set the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.

29. An engine control unit including a control program for causing the computer to control an internal combustion engine including an exhaust passage through which exhaust gases flow,

wherein the control program causes the computer to detect an air-fuel ratio of the exhaust gases

flowing through the exhaust passage, calculate a reference input based on an output deviation which is a deviation between the detected air-fuel ratio and a predetermined target value, input the calculated reference input to a $\Delta\Sigma$ modulation algorithm, to thereby calculate a modulation output as an output from the $\Delta\Sigma$ modulation algorithm, and control an air-fuel ratio of a mixture supplied to the engine according to the calculated modulation output such that the detected air-fuel ratio converges to the target value, and

wherein when the control program causes the computer to calculate the modulation output, the control program causes the computer to limit an integral of an input deviation between the reference input and the modulation output, in the $\Delta\Sigma$ modulation algorithm, to a value within a predetermined limited range.

30. An engine control unit as claimed in claim 29, wherein the exhaust passage has a catalytic device disposed therein, and

wherein when the control program causes the computer to calculate the reference input, the control program causes the computer to set the reference input to a value obtained by multiplying the output deviation by a predetermined different value dependent on whether the output deviation is a positive value or a negative value.